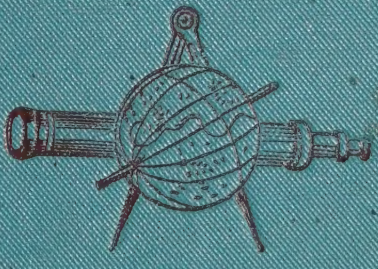
THE STORY OF GALILEO

THE ASTRONOMER OF PISA



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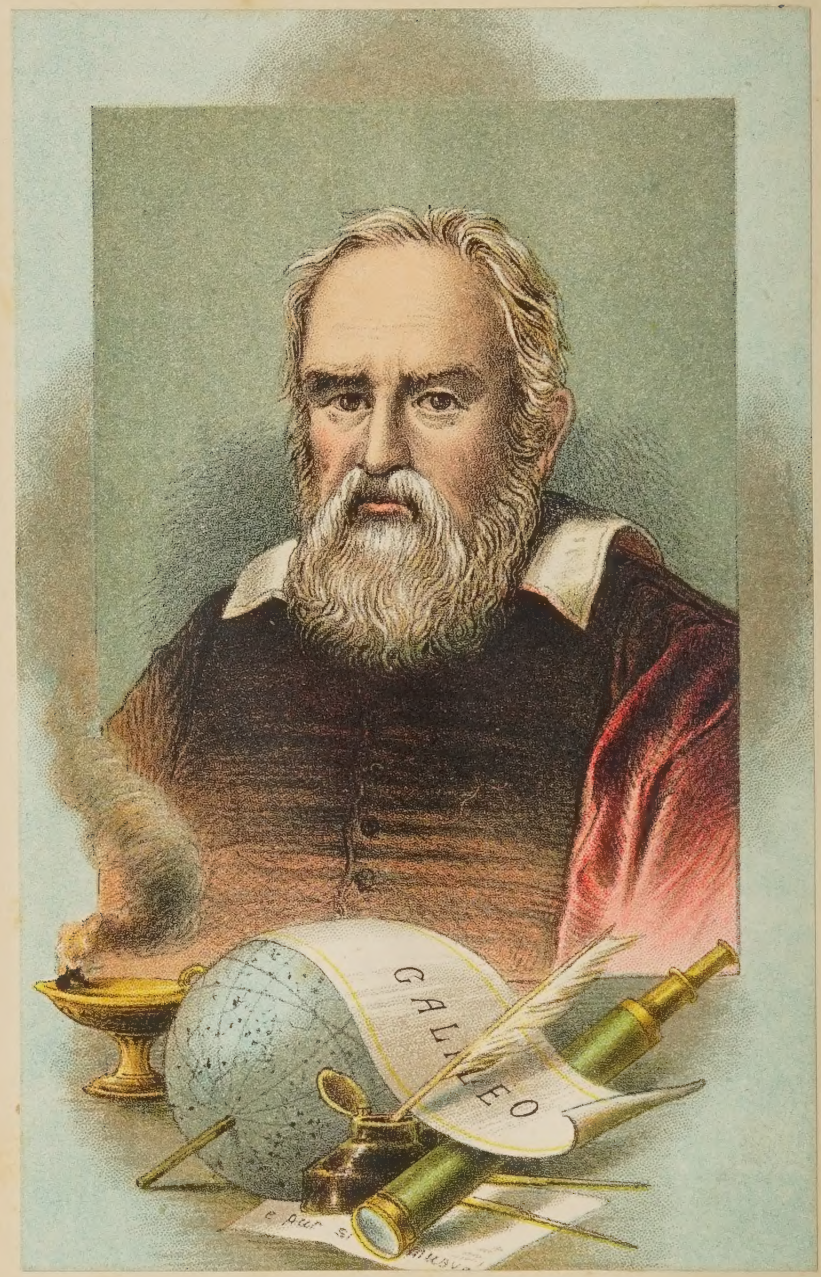
GALILEO

THE

STORY OF GALILEO

THE ASTRONOMER OF PISA.

"And starry Galileo, with his woes."

BYRON.

London:

T. NELSON AND SONS, PATERNOSTER ROW.

EDINBURGH; AND NEW YORK.

1886.

Preface.

WE have attempted, in the following pages, to furnish the young reader with an accurate and comprehensive sketch of the life, writings, and discoveries of one of the greatest of the medieval philosophers, the "starry Galileo." It has been prepared after a careful comparison of the best and latest authorities, and embraces, it is believed, every fact of interest and importance. The full value of Galileo's scientific labours may not be appreciable by youthful students; but they will understand the lessons of his life. They will see that perseverance never fails to secure the reward it deserves; that the plea sures of knowledge amply compensate for any trials undergone in acquiring it; and that the triumphs of ignorance and bigotry are always of the briefest duration. This, indeed, is the

one special truth taught by the career of Galileo,—that truth is eternal and immutable, and, sooner or later, will rise above the clouds with which human folly and fanaticism delight to surround it.

Incidentally, this little volume touches on a question now exciting general attention,—the relation between science and religion; and it helps to show that the latter has nothing to fear from the former. Galileo was a scientific enthusiast, but he was also a sincere Christian. The progress of scientific inquiry can never interfere with the revelation of God. As Macaulay says, in those things which concern this life and this world man constantly becomes wiser and wiser; but he knows no more of his past and his future than the Divine Word opens up to him. And the result of all invention and all discovery, with the devout and humble mind, will be to strengthen its faith in the love, wisdom, and power of Him who is the source of science no less than of theology.

Contents.

CHAPTER I.

HIS EARLY CAREER.

Birthplace and parentage of Galileo—His education—Of a persevering disposition—His versatility—Intended for a physician—Anecdote of his quickness of observation—Oscillation of the pendulum—Instrument for measuring the pulse-beats—His natural bias towards mathematical study—Abandons the profession of medicine—A hint to youthful students 11–19

CHAPTER II.

AN EXPERIMENTAL PHILOSOPHER.

Galileo is made Professor of Mathematics at Pisa—Adopts the Copernican System of astronomy—Teaching of Benedetti and Giordano Bruno—Galileo an experimental philosopher—Declaims against Aristotle—His experiment at the Campanile—Offends Giovanni dei Medici—Forced to leave Pisa—Obtains the Mathematical Chair in the University of Padua—Invents the thermometer—His popularity as a lecturer—A new coloured star—Invention of the astronomical telescope—Discovers the lunar aspects and the satellites of Jupiter—Fame of the "Venetian glass" spreads over all Europe—Quotations from his letters—Removes to Florence—Continues to study the phenomena of the moon—The Milky Way..... 20–40

CHAPTER III.

AN AGE OF INTOLERANCE.

Invention of the microscope—Galileo as a telescope-maker—Dark clouds on the horizon—Opposition of the Church of Rome to the

Copernican System, and hence its suspicion of Galileo--He insists on the truth of the system—His writing denounced to the Inquisition—Visits Rome—The Inquisition prohibits all works teaching that the earth moves round the sun—By his bold speaking, Galileo provokes fresh enmities—Is recalled to Florence—Accession of Pope Urban VIII.—Previous friendship between the Pope and Galileo—The latter publishes his *Saggiatore*, or "The Assayer"—Galileo visits the Pope, and is well received—His "Dialogues on the Ptolemaic and Copernican Systems"—His enemies prejudice Pope Urban against him—Has much difficulty in getting his book printed—Published at Florence in 1832—Anger of the theologians—The Inquisition forbids its sale—The Grand Duke of Tuscany interferes on behalf of Galileo—His ambassador's interview with the Pope--Galileo summoned to Rome—Is allowed to lodge at the Tuscan ambassador's house—The Pope declares his teaching heretical—Inflexible obstinacy of Rome..... 41–62

CHAPTER IV.

GALILEO'S TRIAL AND RECANTATION.

The Tuscan ambassador again intercedes with the Pope, but in vain—Galileo brought before the Inquisition, and imprisoned—Rome's warfare against science as represented by the astronomer—His defence—The Inquisition condemn him as guilty of heresy—His sentence—Is compelled to abjure his teaching publicly in the Church of Santa Minerva—A formal recantation—Galileo's humiliation a matter for regret—An old tradition disproved—Temporary triumph of the Roman court, but eventual victory of science—Rome's blunder in the case of Bishop Virgil—Its severe treatment of Galileo indefensible—Tiraboschi's apology a mistake—Galileo removed to Sienna—His daughter Maria, and her affectionate prudence—He returns to his home at Arcetri—His daughter's death—He is visited by Milton..... 63–97

CHAPTER V.

LAST YEARS.

Quotations from Galileo's "Dialogues"—Writes a treatise on Motion—Letter from Micanzio—Prints his book at Amsterdam—Writes to Peiresc—Continues his astronomical studies—Is overtaken by blindness—Honours paid to him by the Dutch Government—His gradual decay, illness, and death—Is buried privately in Santa Croce—His person described—His character—Deserves to be remembered as a benefactor of mankind..... 98–114

Authorities.

Philarète Chasles, "Galileo Galilei: sa Vie, son Procès, et ses Contemporaires;" "Vies des Savants Illustres," par L. Figuier; "Life of Galileo," by Drinkwater; "Life of Galileo," by Sir David Brewster; "Lives of Eminent Persons," in Library of Useful Knowledge; and "The Private Life of Galileo," published by Macmillan, 1870.

THE STORY OF GALILEO GALILEI.

CHAPTER I.

HIS EARLY CAREER.

WE purpose to tell the story of the life of an enthusiast—of GALILEO GALILEI, the Italian philosopher, to whom Humanity owes much, and Science still more.

He came of a noble but decayed family, who had formerly borne the surname of Bonajati. His birthplace was Pisa, and his natal day the 18th of February 1564—the day which witnessed the death at Rome of the illustrious Michael Angelo. His parents, Vincenzo Galilei and Guilia Ammanati, resided at Florence; but he was born during a visit which they paid to the rival city of Pisa.

The house in which he first saw the light is still extant, and a marble tablet on its front bears the inscription, "Qui nacque Galileo Galilei." Its appearance is very modest; it consists of two stories, and opens out on a spacious garden. It was in a small chamber on the upper story that the Tuscan philosopher was born.

His father, Vincenzo, was a man of education, well versed in both the theory and practice of music, in Greek and Latin literature, and even in mathematical science. He published some treatises on music, which were well received. His "Dialogue on Ancient and Modern Music" exhibits, it is said, a thorough knowledge of the subject.

Returning to Florence, he took particular pains with the education of his son, though he intended him for a commercial life. He studied both Latin and Greek, and in their language and literature made a very rapid progress. He also received lessons in philosophy from a monk of the Abbey of Vallombrosa.

At an early age he evinced a decided taste for mechanics. He amused himself with the

construction of several miniature machines, and apparatus of various kinds; and he showed much ingenuity in the way in which he made up for want of exact information. The reader will remember that the childhood of Newton was characterized by a similar partiality. This mechanical "turn," however, is not uncommon in active boys, who do not all develop into Newtons or Galileos.

Galileo's father was not rich, and he had a family of six children, of whom the future astronomer was the eldest. After a while he found it beyond his means to provide the youthful student with as complete an education as he desired. It was fortunate that Galileo was of a persevering and resolute disposition, well fitted to struggle against this formidable obstacle. He gave up his whole time to study. One portion of every day he devoted to literary pursuits; the other, to music and drawing. For music he exhibited a natural gift, and soon acquired considerable command of several musical instruments. The lute, to which he was extremely partial, remained throughout life his favourite recreation. For

painting he showed an equal aptitude and a similar liking. At one time he even conceived the idea of making it the principal object of his studies, and of seeking in it the support of himself and his family. So well known were his musical skill and fine taste, that eminent artists, his contemporaries, confessed the value of the criticisms of the young Galileo. Here it may be observed that a similar versatility distinguished many of the Italians of the medieval period. Michael Angelo was poet, painter, and sculptor; Leonardo da Vinci was an almost universal scholar; Benvenuto Cellini was a master of many arts and sciences. These strong, fresh, healthy minds did not dwarf their energies by limiting them to a single pursuit; but strengthened their wings by exercising them in an assiduous flight over the whole realm of knowledge.

Galileo's intellectual superiority was so marked at the age of sixteen, that his father abandoned his original intention of training him for a commercial life, and resolved to make him a physician. At no inconsiderable sacrifice he sent him to Pisa to study at its far-famed

university; and before he had reached his twentieth birthday, his name was duly inscribed upon its registers (November 5, 1584). Viviani, his friend and disciple, has left it upon record that the young student had not long attended lectures before he manifested a strong repugnance to the old traditions and fallacies which then passed in Europe under the sublime name of Philosophy. His keen eye saw through the sham, and his courageous intellect soon denounced it.

He was in his twentieth year when he gave at Pisa an interesting proof of his quickness of observation and his experimental tact. One day, after divine service in the cathedral, his attention happened to be directed to the oscillations of a lamp suspended to the ceiling, which having been drawn aside from its vertical position for the convenience of lighting, had then been abandoned to its own motion. How many thousands had previously gazed indifferently on a circumstance so common, without for one moment supposing that any relation existed between the oscillations of a body suspended by a cord and the measurement of time. But,

endowed with an extraordinary faculty of observation, Galileo remarked that the movements to and fro, great or small, seemed to be performed at regular intervals. He did not leave the church until he had put his observation to the test of experiment; but as he had no watch, he measured the oscillations of the lamp by the throbbings of his pulse.

Besides deducing the great principle of "the isochronism of the oscillations of the pendulum," —that is, that movements of the same length it performs always in the same time,—he came to the conclusion that the oscillations of a suspended body vibrating around the point of suspension might be useful in verifying those of the beating of the pulse. In 1603, Santorius, a physician of Padua, first published an account of a small instrument, the *Pulsilogium,* intended to measure the quickness of the pulse. But the evidence is overwhelming that Galileo had anticipated him, and had conceived the idea of such an instrument during his student-years at Pisa.

Galileo, at the time he made this discovery, knew very little of mathematics. He had ex-

pressed a desire, it is said, to learn something of geometry, so that he might satisfy himself as to the general principles which equally serve as the foundation of music and perspective ; but his father would not consent, from a fear that he would absorb himself in geometrical to the neglect of his medical studies, while apparently it was the latter only which could secure him a distinguished position and an honourable competency. From this point of view his father was probably right. For the exact and profound intellect of Galileo, mathematical science, with its certainty of demonstration and accumulation of proof, had necessarily an attraction not to be found in the then chimerical "science" of Medicine, with its guesses, its extravagances, its ignorance of the laws of physiology, and its superstitious adherence to the most preposterous remedies. In Galileo's days every physician was more or less a quack, because medicine itself, as then taught and practised, was more or less a sham.

The bias of a strong intellect is not easily resisted; and Galileo was not long in deserting the interminable labyrinth of Medicine for the

clearly defined paths of Geometry. Under the guidance of a certain Ostilio Ricci he began to study Euclid's Elements; a book for which most English schoolboys have a very real detestation. His father, good easy man, supposed at first that his clever son had taken up the study as a kind of recreation in the intervals of his abstruser pursuits; but he soon discovered his error. Galileo grew so passionately attached to Euclid, that Hippocrates and Galen soon figured on his table only as a matter of show. Opened haphazard, these ponderous folios were exceedingly useful to hide or screen the little manual of Euclid, in case of an inopportune visit from Galileo's father; just as an idle scholar conceals beneath his Virgil and Latin Dictionary the delightful but forbidden page of "Robinson Crusoe" or "Tales of the Smugglers." In Galileo's case, however, the deception was somewhat less blameworthy, for he was simply abandoning a study unsuited to the bent of his genius for one in which he was fitted to excel. His father made several efforts to turn back his errant son to the arid wastes of Medicine, but all proved useless; and at

length he had the good sense to leave him to the free exercise of his undoubted powers.

We would warn our young readers, however, against supposing that the example is one which they will do well to imitate. As a rule, a father is a better judge than his son of the career which the latter should adopt; and boys who plead the example of Galileo, should first be sure that they possess Galileo's genius!

CHAPTER II.

AN EXPERIMENTAL PHILOSOPHER.

THE young mathematician progressed rapidly in the study which he had embraced with so much enthusiasm; and no doubt we all of us succeed best when our heart is in our work. He was encouraged liberally by the Marquis Guido Baldi, then one of the mathematical "lights" of Italy; and presented by him to his brother, the Cardinal del Monte, who spoke of the rising genius to Ferdinand dei Medici, Grand Duke of Tuscany. The prince, like all of his race, was prone to favour men of ability; and in 1589, when Galileo was still but twenty-five years of age, he appointed him Professor of Mathematics at Pisa. The emolument, it is true, was scanty—only sixty crowns a year; but his genius and

activity soon drew around him a numerous class of pupils.

We have said that Galileo, when a student at Pisa, boldly rejected the principles of the old philosophy; and it seems probable that his brilliant audacity had excited against him the rancour of some of its warmer adherents. We conclude, at all events, that he had in this matter a revenge to take, from the eagerness with which, as soon as he was installed in his chair, he put to the test of experiment the principles of the teaching of Aristotle relative to Mechanics. He quickly demonstrated that they were radically false.

It was his habit to write out his course of lectures, and to circulate the various parts in manuscript among his pupils; for he was not rich enough to pay for printing them. Several of his manuscripts, dated 1590, were discovered some years ago by Venturi, in the private library of the late Grand Duke of Tuscany. They suggest various theorems on the theory of motion, which Galileo afterwards developed more fully in his "Dialogues." It is conjectured by Sir David Brewster that he owed

some of his ideas on this point to the great master, Leonardo da Vinci, with whose friend, Mazenta, Galileo was acquainted.

We do not know certainly when Galileo adopted the astronomical system of Copernicus; but it would naturally recommend itself to his clear and logical intellect. Before his time, however, many efforts had been made to get rid of the ancient astronomy. About the date of Galileo's birth, Benedetti wrote against Aristotle. He proved, for instance,—what, indeed, every schoolboy now knows,—that all bodies fall from the same height in equal periods of time; a fact which Galileo afterwards carried further, showing that, as regards the fall of bodies, the velocity is equal to the time, and that the spaces traversed freely by a falling body are in the ratio of the squares of the velocities. These propositions to some of our readers may seem obscure, and even uninteresting, but they lie at the very root of that science of Dynamics which Galileo created at the age of twenty-five.

Before Galileo, moreover, another man of genius had broken through the bonds of the

old order; but as Papal Rome feared originality and hated intellectual freedom, it burned the unfortunate reformer in 1600. We refer to Giordano Bruno, who taught that the universe consisted of innumerable solar worlds, like our own earth. Around each sun, he said, as around our own sun, gravitated various planets, other Mercuries, Venuses, and Saturns, which were invisible to mortal eyes on account of their vast distance. Bruno, moreover, thought it probable that even in our own solar system orbs existed which in his time it was impossible to discern; and he accounted for their invisibility by the smallness of their volume compared with their remoteness. He did not admit that the so-called "fixed stars" were really immovable. At least, the point seemed to him one that could not be proved except by a series of careful observations prolonged over many years. It will thus be seen that his genius anticipated the discoveries of later astronomers. Alas, it is dangerous for a man to be in advance of the age he lives in! Bruno, as we have said, was burned at the stake as a heretic, and his works were denounced as

impious. But he had opened up a field of research and speculation which not even the menaces of Rome and the terrors of the Inquisition could close against adventurous minds in search of truth, and anxious to behold the glory of God as recorded in His Creation.

The secret of Galileo's philosophy was this: he accepted nothing until he had submitted it to the ordeal of experiment. For example: Aristotle, the Greek logician, had asserted that if two bodies of the same substance,—let us say two balls of lead,—but of different weights, fell from the same height, the heavier would reach the ground first, its velocity being in proportion to its weight. It is clear that Aristotle can never have put his own assertion to the proof; but for centuries it was accepted without demur, simply because Aristotle had said so. To prove or disprove it by experiment was easy enough, yet no one thought it worth while to confute or confirm the great Stagirite's utterance. Galileo, however, boldly maintained that, with a very slight allowance for the resistance offered by the atmosphere, two bodies of unequal weight

would fall from the same elevation in the same time.

Protest against the inherited prejudice of ages, and, lo! what a storm will break about your head! But we must not be too severe upon the antagonists of Galileo; in our own time we have seen numerous instances of the dangers incurred by those eager spirits who attempt to overthrow a received theory. So we must deal gently with the conservative philosophers of the University of Pisa, who clung desperately to the skirts of their idol, Aristotle. Of course, they inveighed bitterly against the presumptuous Galileo. What did the young man mean by venturing to question the authority of the great Greek master? Was it not evident that a body weighing ten pounds would descend to the ground ten times as quickly as a body weighing one pound? That is, a ball of ten pounds would fall to the ground in a minute, while a ball of one pound would occupy ten minutes?

Galileo knew it was useless to resort to reason: he preferred to convince, if possible, by ocular demonstration. So, in the presence

of the philosophers, he let fall from the summit of the Tower of Pisa two bodies of unequal weight. The noise made by each when it came to the ground served to mark the duration of the fall. In this way he established the fact that the time occupied in traversing the same distance is not in proportion to the weight of the body.

This simple experiment, executed from the summit of the Leaning Tower or Campanile of Pisa, was witnessed by a great number of students and members of the university, as well as by a curious crowd. Of course, it failed to convert the bigoted supporters of the ancient system; it did not fail, however, to inspire them with an implacable hatred of Galileo, whom they determined, by fair means or foul, to expel from Pisa.

And, unluckily for our young reformer, he contrived to offend a personage whose wealth and connections made him very influential in Tuscany,—namely, Giovanni dei Medici, the natural son of Cosmo. Of mechanics and architecture the patrician amateur had acquired a superficial knowledge; and like most men who

know little, he was wonderfully proud of what he knew. In this sense the well-known couplet of Pope is true enough :—

> "A little learning is a dangerous thing;
> Drink deep, or taste not the Pierian spring."

Profound knowledge is always accompanied by modesty, because it is able to discern how much more remains to be known. Giovanni dei Medici, in his capacity as mechanician, had invented, for the purpose of cleansing the harbour of Livorno, a peculiar dredge. Galileo was invited to give his opinion upon it, and that opinion was unfavourable. When the dredge was set to work, Galileo's opinion was confirmed. This was enough to influence the minds of Giovanni and his courtiers against the candid critic; and thenceforward they pursued him with relentless enmity. Such, at least, is the common tradition; but we are inclined to believe that something remains behind. It may be that Galileo expressed himself in terms of too undisguised sarcasm; and that he wounded the vanity as well as the pride of the princely inventor.

Certain it is that the Pisan professors, sup-

ported by Giovanni dei Medici, soon contrived to make Galileo's position untenable. He was forced to leave Pisa; but the recommendation of his friend the Marquis Guido Ubaldi procured him the mathematical chair in the University of Padua for ten years. Thither he betook himself in 1592. The emoluments were not very considerable; but the post suited him better than the professorship at Pisa. A much greater freedom of thought and speech was permitted; he even found himself at liberty to attack the Jesuits and their bigoted intolerance, which made them the determined enemies of the New Learning. He had more leisure, too, for his scientific pursuits, and less anxiety about his daily bread.

About 1602, Galileo devised the thermometer; the invention of which has sometimes, but erroneously, been ascribed to Santorio. Castelli's evidence on this point is incontrovertible:—"I remember," he writes in 1638, "an experiment which one Signor Galileo showed me more than thirty-five years ago. He took a glass bottle about the size of a hen's egg, the neck of which was two palms long,

and as narrow as a straw. Having well heated the bulb in his hand, he placed its mouth in a vessel containing a little water; and withdrawing the heat of his hand from the bulb, instantly the water rose in the neck more than a palm above the level of the water in the vessel." Of course, as the tube cooled the water sank. This simple instrument was the germ of the thermometer. Ferdinand II. of Tuscany afterwards introduced some improvements into its construction. Galileo went no further than to use spirits of wine instead of water. Mercury was not rendered available until 1670.

At the expiration of the first decade of the philosopher's professorship, the appointment was renewed for another ten years, and the salary increased from 180 to 320 crowns. His reputation was now extending over all Europe. His lectures attracted a brilliant concourse of hearers; among them the Archduke Ferdinand, the Landgrave of Hesse, and the Princes of Alsace and Mantua; and by the Grand Duke's desire he taught mathematics to the young Prince Cisano, a clever inquiring lad of twelve. The treatises which he wrote on a vast variety

of subjects were eagerly copied by his disciples; and the manuscripts, circulating from hand to hand, made known his original and brilliant ideas to men of science in all the chief European countries.

On the 9th of October 1604, a new and glorious star shone forth in the constellation *Serpentarious,* and attracted the attention of all the astronomers of Europe. Like many other new stars which had previously been observed, it changed its colour frequently; sometimes it was yellow, sometimes red and purple, sometimes white. The phenomenon was necessarily a cause of speculation, and Galileo made it the subject of three lectures. His auditors increased in number to such an extent that Padua had no hall large enough to hold them,—not even that of the School of Medicine, though it could accommodate one thousand persons,—and often he was compelled to discourse in the open air.

Five years later, Galileo made the discovery which, more than anything else, has handed down his name to posterity—namely, that of the telescope. The honour, however, has very

unwillingly been given to him. Various writers have endeavoured to claim it for Baptista Porta, Girolamo Fracastoro, and De Dominis, the learned Archbishop of Spalatro; while others have supported the title of a Dutchman named Jansen. It does seem, indeed, that Jansen invented a toy which served to bring objects nearer to the eye of the spectator; but for the astronomical telescope which has revealed to man the hitherto unexplored sidereal depths the world is certainly indebted to Galileo. Writing to his brother-in-law, he gives the following account of his invention :—

"You must know that about ten months ago I received information that a certain Dutchman had presented to Count Maurice of Nassau a glass (*occhiale*)* manufactured in such a way as to make distant objects appear very near; so that you could plainly see a man at the distance of two miles. This seemed to me so marvellous that I began to think about it; and as I conceived that it had a foundation in the science of perspective, I set about reflecting how it might be made. This at length I

* In his "Nuntius Sidercus" he calls it *perspicillum*.

found out; and I have succeeded so well that the one I have made is superior to the Dutch telescope. The report having reached Venice that I had made one, a week since I was commanded to show it to His Serenity the Doge, and to all the members of the Senate, to their exceeding astonishment. Many patricians and senators, even the most venerable, have at various times ascended the highest bell-towers in Venice, to make out ships at sea sailing towards the mouth of the harbour, and have seen them plainly, though without my telescope they would have been invisible for more than two hours. The effect of this instrument is to show an object at a distance of say fifty miles, as if it were but five miles off.

"Recognizing the usefulness of such an instrument in naval and military warfare, and observing His Highness's strong desire to possess it, I resolved four days ago to call at the Palace and offer it to the Doge as a free gift. On quitting the presence-chamber I was commanded to wait in the Hall of the Senate; where, after a short time, I was joined by Prioli, who is one of the officials of the university,

and he, taking me by the hand, said that the Senate, knowing how faithfully I had served it for seventeen years at Padua, and sensible of my courtesy in making it a present of my telescope, had immediately ordered my appointment (with my consent) to the professorship for life, with a stipend of 1000 florins yearly; and as a year still remained to terminate the period of my last re-election, it was their pleasure that the increase of stipend should date from that same day. I, knowing that Fortune's wings are swift, but that those of Hope are drooping, said that I was content to abide His Serenity's pleasure."

At first Galileo, like most inventors, appears to have been ignorant of the full value of his discovery; but by degrees, as he surveyed the starry systems, and found world after world coming within his ken, he learned to appreciate its importance. Directing his magic glass towards the vault of heaven, he gazed upon wonders which no human eye but his had ever contemplated. He saw the moon with all its "configuration strange" of mountains and deep shadowy valleys and seas without water. To

estimate the height of the lunar mountains, he took into consideration the luminous points which their summits present when their sides and bases are plunged in shadow. These luminous points, if noticed when the moon is in her first or last quarter, appear in the obscure or ashy part, at some considerable distance from the part which is illuminated. This distance Galileo compared with the moon's diameter, and the various physical appearances detected by his watchful eye suggested a number of interesting conclusions. The phenomenon of the *ashy* light he explained as the reflected light which the moon received from the earth. He discovered that the "orb of night" turns always the same face towards the earth; and he inferred that a star in which each point of the surface remains for fifteen days in shadow, after having been illuminated by the sun for an equal interval of time, must experience variations of temperature such as none of the organized bodies existing on the surface of our planet could possibly endure.

The telescope which thus opened up to him a new and inexhaustible field of inquiry, he

continued very assiduously and skilfully to improve. Its fame was soon noised abroad in every land, and a demand for the marvellous glass was preferred to him by astronomers, princes, nobles, wealthy merchants, all eager to survey the world-studded regions of space. One of Galileo's earliest discoveries was that of the satellites of Jupiter; which, in compliment to the Grand Duke, he named *Medicea Sidera*. The Grand Duke immediately desired to see the stars which thus, as it were, inscribed his name on the face of the heavens; and Galileo had to visit his Court for the express purpose. All Florence was roused to enthusiasm. Every one longed to possess what was known as "the Venetian glass." Michel Angelo Buonarotti, nephew of the great painter, wrote a sonnet; and Thomas Segget or Segheto, a learned Englishman, invented Latin epigrams in his friend's praise. When Galileo lectured on his discoveries, the whole university crowded to hear him. Kepler, the illustrious astronomer, hailed them with delight. To us, familiar from our childhood with the celestial wonders,—to us, born in an age when astronomical research has

mapped out the "profundities of space," the wild excitement which pervaded civilized Europe as Galileo's labours became known, may seem unintelligible; but we must remember how they replaced conjecture by accurate knowledge, and helped to revolutionize all our ideas of the economy of the universe.

As this little volume is designed for the encouragement and instruction of young minds, it is fitting that we should show the intense industry and perseverance of Galileo, and illustrate his conscientious desire to make the best possible use of his intellectual gifts. He did not rest content with what he had done; he was spurred onward by his success to fresh attempts. Thus he writes:—"Daily I discover new things; and had I more leisure, and were I able to employ a larger number of workmen, I should accomplish much more in the way of experiment and invention. You ask for some details respecting my earnings: well, my lectureship is worth 520 florins, which I feel assured will be increased to as many crowns on my re-election. This I can easily put by, as I

am greatly helped in the maintenance of my household by taking pupils, and by giving private lessons, of which I can give as many as I choose. This I say because I refrain from doing so, wishing for more leisure rather than much gold; for it would be easier to me to gain renown by my studies, than by working for such a sum of money as might render me conspicuous amongst men."

At another time he writes:—"The works which I desire to finish are principally these:—two on the system of the universe: an immense *concetto,* or idea, concerning philosophy, astronomy, and geometry: three books on local motion,—an entirely novel science, since no one, either among the ancients or the moderns, has discovered any of the wonderful accidents which I demonstrate in natural and violent motions; therefore I may with very great reason call it a new science, discovered by me from its very first principles: three books on mechanics, two on the demonstration of its elements, and one of problems; and though this is a subject which various writers have already treated, yet all which has hitherto been written does not, in

quality or otherwise, amount to one fourth of what I am writing on it. I have also divers treatises on natural subjects, on sound and speech, on sight and colours, on the tides, on the composition of continuous quantity, on the motions of animals, and other topics. Further, I have an idea of writing some books on the military art, furnishing not only a model of a soldier, but teaching with very exact rules all it is his duty to know so far as depends upon mathematics; as, for example, the knowledge of arrangement, the drawing up of battalions, fortifications, assaults, planning, surveying, the knowledge of artillery, and the use of various instruments."

It is difficult to know whether we should more admire the wonderful industry or the extraordinary versatility of Galileo Galilei!

In 1610 the astronomer removed to Florence, at the desire of the Grand Duke and his able wife, Marie dei Medici. It is told of the latter, that in her eagerness to see the moon through the telescope she would not wait for its adjustment, but threw herself down on her knees before the window, much to the astonishment

of the Italian gentleman who had brought the telescope into the royal presence.

But, like all discoverers, Galileo met with captious critics and doubters. His observations on the moon, for example, were condemned as false or absurd by several so-called men of science, and especially by the priests, who were really unable to comprehend them. Opposition, however, did but quicken and maintain the astronomer's enthusiasm. For thirty years he studied and re-studied the lunar world, constantly adding to his valuable discoveries. He was the first to detect the phenomenon of *libration;* that is, the periodical oscillatory movements of the moon,—indicated by the alternate appearance and disappearance of certain spots in close contiguity to the borders of its disc.

The oceans, the continents, the mountains, the valleys, which Galileo believed himself able to discern, suggested to him the idea that the moon was inhabited; an idea which, however, later astronomical research has effectually discredited. He also recognized the fact that telescopes do not enlarge the fixed stars; and

that the Milky Way is a starry mass. So Milton says :—

> "That Milky Way
> Which nightly, as a circling zone, thou seest
> Powdered with stars."

Afterwards he determined the orbits of Jupiter's satellites, and the periods of their revolutions round the central orb. The analogy which he detected between the moons of Jupiter and our terrestrial satellite appeared to him a new argument in favour of the Copernican theory. And the idea also occurred to him of utilizing the eclipses of those moons in determining the latitude at sea,—a problem of the highest importance for navigators.

CHAPTER III.

AN AGE OF INTOLERANCE.

IN 1612 Galileo invented the microscope,—an instrument constructed on exactly the same principles as the telescope. He presented this new marvel to Sigismund, King of Poland. But his thoughts were chiefly engaged in perfecting and employing the telescope, and the microscope long remained in his hands in a rude and unfinished condition. As late as 1624, we find him writing to the Prince Cisano, that he deferred sending him the microscope, the uses of which he described, because, having met with some difficulties in preparing the lenses, it was only quite recently he had been able to give it a finishing touch.

Astronomical glasses of inferior quality were

soon manufactured in large numbers in Holland and Germany. These spread everywhere, like a new toy, or just as in our own days we have seen the kaleidoscope and the spectroscope rise into popularity. Meantime, the scientific construction of telescopes was still entirely confined to the hands of Galileo and his pupils. And it is a proof of the indubitable claim of the great astronomer to the honour of this invention, that not until 1637 could there be found in all Holland a glass which distinctly revealed the disc of Jupiter.

Hitherto the course of Galileo's life had been fair enough. He had gone on from honour to honour. His renown had daily increased; he counted his disciples by hundreds, and among them were some of the highest rank; everybody longed to hear his latest discovery, and admired the genius and the resolution which had taken possession, as it were, of the world of space. But gradually a heavy cloud was gathering on the horizon. Galileo had embraced the Copernican system of the universe, which represented the sun in its fixed centre, and the planets as

revolving round it in their respective orbits—thus defined by the poet :—

> "What if the sun
> Be centre to the world; and other stars,
> By his attractive virtue and their own
> Incited, dance about him various rounds?
> Their wandering course, now high, now low, then hid,
> Progressive, retrograde, or standing still,
> In six thou seest; and what if seventh to these
> The planet earth, so steadfast though she seem,
> Insensibly three different motions move?"

This, however, was not the theory approved by the Church of Rome, which laid it down as an article of faith that the earth was the immovable centre of the system, and that the sun revolved around it. The influence of Galileo's discoveries had told in favour of the Copernican system, and though the latter was denounced by ignorant priests as heterodox, it began to obtain a very wide acceptance. Hence, the authorities of the Church looked suspiciously upon Galileo and all his works, and regarded with alarm the spirit of free inquiry which he had so largely helped to set in motion. When Bernardo Castelli, his friend and disciple, was about to enter on a course of mathematical lectures at Pisa, he was warned that no allusion must be

made to the theory of the earth's motion. Castelli answered very prudently, and then communicated on the subject with his great master. The latter, in reply, insisted on the truth of the Copernican theory, and protested against its being stigmatized as unscriptural. "Though Scripture cannot err," he said, in language liberal enough for the present day, "its expounders and interpreters are liable to do so in many ways; and one error in particular would be most grave and frequent, if we always stopped short at the literal signification of the words. For in this wise not only would many contradictions be apparent, but grave heresies and blasphemies. It would then be necessary to give God hands and feet and ears, and human and bodily emotions; such as anger, repentance, hatred, and sometimes forgetfulness of things past and grievance of things to come. Holy Scripture and Nature are both emanations from the Divine Word: the former dictated by the Holy Spirit; the latter, the execution of the Divine commands. And who can assert or maintain that, in speaking incidentally of the sun, or of the earth, or of other created bodies,

Scripture should have elected to restrain itself rigorously to the strict signification of the words employed?" He concludes in words which exactly apply to some of the controversies of the present day :—"I believe that the intention of Holy Writ was to persuade men of the truths necessary to salvation; such as neither science nor other means could render credible, but only the voice of the Holy Spirit. But I do not think it necessary to believe that the God to whom we owe our senses, our speech, our intellect, would have us forfeit their use, and teach us instead such things as, with their help, we could discover for ourselves, particularly in the case of these sciences, of which not the slightest notice occurs in the Scripture; and, above all, in astronomy, of which so little mention is made that the names of all the planets are not specified. Surely, if the sacred writers had intended to teach the people astronomy, they would not so completely have passed over the subject."

By some mishap, a copy of this bold, liberal, and unanswerable plea for freedom of inquiry, fell into the hands of the Dominicans of St.

Mark. To their narrow minds it smelled of rank heresy ; and they speedily satisfied themselves that it would be an act of true religion to burn its heretical writer. They denounced it, accordingly, to the Holy Inquisition ; they preached against it, they wrote against it, and aimed at allying themselves with the partisans of the old Aristotelian philosophy, in order to strengthen themselves in their attacks upon the heretical doctrines. Nor had the Papal Court failed to watch the progress of the bold reformer,—enraged not so much at his discoveries, as at the audacity of a layman in undertaking to interpret the Holy Scriptures. Galileo was apprised of the danger which threatened him, and came to the conclusion that he would visit Rome, to judge for himself of its extent. He carried with him letters of recommendation from the Grand Duke. There he exerted in his defence all his powers of argument and eloquence ; but though it was easy to confute, it was impossible to convince his opponents. When he appealed to reason and observation, they fell back on the authority of the Church. On the other hand, they were

unable as yet to prove him guilty of heresy; and as they failed to secure a living victim, they pounced upon one which could not plead on its own behalf. The Congregation of the *Index*—that is, the body charged with the duty of deciding what books should be included in the *Index Expurgatorius* as unfit to be read by pious Romanists—promulgated a decree, on the 5th of March, which prohibited the great work of Copernicus, and all other works enunciating the principle of the earth's motion.

This decree, as a recent writer observes, though it did not strike Galileo personally, was a great blow to him. That he had escaped personal censure, touched him but slightly. He was a firm believer in the Copernican theory; he had done his utmost to convince others of its truth; and now, the condemnation of that theory was not only a proof of the subservience of the Congregation to the views of an unscientific and perhaps prejudiced Pope, but a movement against the best interests of religion and the welfare of the Church. Religion and the Church could not but suffer, when they were forcibly employed to uphold

a doctrine the falsity of which was easily demonstrated. With his usual courage, he spoke against the unwise and intolerant course of the Congregation; the effect of which was that Guicciardini, the Tuscan Ambassador at Rome, privately advised the Grand Duke to recall him to Florence, to keep him out of danger. Pope and priests, Dominicans and Jesuits, all were in arms against the man who dared to tell the truth, and who persisted in arguing that the earth went round the sun, when the Church had affirmed that the sun went round the earth.

The Grand Duke's message (May 23, 1616) was characteristic:—"You have had a sufficient taste of the monks' persecution to know what flavour it has for you. Their Highnesses fear that a longer sojourn at Rome will involve you in difficulties. They would be glad that you, who have hitherto extricated yourself honourably from your troubles, should forbear from rousing dormant susceptibilities, and return as quickly as possible; for rumours of a very unpleasant nature are abroad."

Galileo obeyed the summons, and returning to

Florence, resumed his eager course of scientific study; but, out of deference to the advice of his sovereign, abstained for several years from publishing aught. He contented himself with writing to the enlightened personages who had embraced the new views; and communicated the result of his researches in lively letters, which, passing from hand to hand, and being repeatedly copied, were distributed widely over Europe. But even this method of promulgating his opinions and discoveries was not without its perils, in the dark days of medieval superstition and ignorance.

To Pope Paul V., of whom the historian Guicciardini said, that he held in equal horror arts and letters, and that he could endure nothing new or subtle, succeeded Gregory XV.; and to Gregory XV. succeeded the Cardinal Maffeo Barberini, under the name of Urban VIII. This latter event, apparently, was much in Galileo's favour. With the new Pope, when Cardinal, he had been on terms of friendship, and Barberini had always shown a cordial appreciation of his genius. He had composed

some Latin verses in his honour, and had sent them to him, accompanied by a letter in which he spoke of his lasting esteem, and his hope that his verses would be welcomed, if not as worthy of the astronomer, at least as a proof of the affection and sympathy cherished towards him. The verses, in truth, were poor, but their sentiment was admirable.

It was in August 1623 that Barberini was raised to the Papal throne; and almost immediately afterwards Galileo dedicated to him his *Saggiatore,* or "The Assayer;" a book in which some of his opponents were weighed in the balance and found wanting. He also paid a visit to Rome, to pay his homage to the new Pope, and at the same time to secure a reversal of the censure which had been so ignorantly levelled at the Copernican system. He was received by Urban VIII. with a particularly cordial welcome; and when he returned to Florence, he carried with him a conviction that men would now be free to think and say that the earth moved.

It soon appeared, however, that he had conceived a false idea of the Papal influence. Urban

VIII., whatever his individual prepossessions, was fettered by the sentence which, in his predecessor's pontificate, had been pronounced by the Congregation of the *Index*. This sentence had all the force of law, and the Pope could not cancel or ignore it without destroying his own authority.

To confirm him, however, in his friendly inclinations, the astronomer undertook two journeys to Rome—one in 1628, and the other in 1630.

On the latter occasion he carried with him the manuscript of his "Dialogues on the Ptolemaic and Copernican Systems;" of which, as his accusers afterwards laid great stress upon it, it may be desirable that we should give a brief account. This work was the result of sixteen years of laborious study. In order to render its scientific truths attractive, Galileo has put forward in it the most subtle and refined wit, and the utmost delicacy of illustration and argument. He brings upon the scene three interlocutors. Two of those are Venetians, Sagredo and Salviati, men of the world, clever and well-informed, who listen,

examine, discuss, suggest doubts, and yield only to incontrovertible reasons. The third, Simplicio, is a philosopher of the old school, a fanatical admirer of what was known as the scholastic philosophy, who declares a thing true or false according as it is conformable or opposed to the assertions of Aristotle. The lightest jest on this subject is gall and wormwood to Simplicio, whose fanatical devotion to the Stagirite is impregnable against all argument.

It was in consequence of this great work that the quarrel between the Pope and Galileo broke out, which terminated so rapidly in the accusation and condemnation of the Florentine astronomer before the Inquisition. Previously, nothing had disturbed the friendship existing between the Pope and his protegé. It was not only that Barberini had lived on the most cordial terms with Galileo, but he had always taken the greatest interest in his discoveries, and had found no reason, and had shown no inclination, to reject the teaching of Copernicus. The publication of the "Dialogues," however, unfortunately raised a cloud between

Urban VIII. and Galileo, which, strengthened and augmented by the enemies of the latter, brought down on his head the storm that finally overwhelmed him.

In order to compass the great astronomer's destruction, his enemies asserted that Simplicio was intended for Pope Urban VIII. The charge was ridiculous. Had he designed to satirize any Pope, it would certainly have been Paul V., who was a blind adherent to the old system. Why should he have held up to laughter and contempt a man who had always been his declared admirer and friend, and whom he had hitherto loaded with the warmest eulogiums? In ascending the Papal throne, Barberini had not flung behind him his scientific opinions; abundant evidence exists that in his private conversations he always supported the Copernican theory. There is not, then, a shadow of proof that Galileo intended to represent Pope Urban in the silly Simplicio. The idea was purely an invention of the Florentine philosopher's enemies.

That a whisper of the calumny had reached the ears of Galileo, may be inferred from that

journey of his to Rome in 1630, of which we have already spoken. He took with him his precious manuscript, which he read to several men of science and culture, his friends; and having profited by their observations, he repaired to Father Riccardi, Master of the Sacred Palace; placed the book in his hand, as a collection of scientific fancies; and begged him to criticize it with the utmost severity, and to excise without scruple everything which seemed to him dubious or objectionable.

Riccardi read the book not once, but twice; then gave it to his colleagues; and no exception being taken to it, he, with his own hand, gave him full permission to print it.

This permission enabled Galileo to send it to press at Rome; but he wisely judged that it would not be long before his enemies at Rome contrived to suspend its production. He found an excuse, therefore, for soliciting a license to print it at Florence, on condition that there it should be examined anew by some duly appointed censor. Such were the difficulties which Rome threw in the way of scientific research in every country where

her claims were acknowledged! The reader should remember that this exercise of arbitrary power took place in 1633, long after Lord Bacon had given to the world his "Novum Organum," and when the English printers were actively engaged in the publication of works of the boldest speculation and freest inquiry!

The Master of the Sacred Palace appointed a censor; but, at the same time, he reclaimed from Galileo the written imprimatur he had given him, the terms of which, he said, would require some revision. No sooner had he got it in his hands than he refused to restore it! In vain the deceived philosopher sought the intervention of the Tuscan Ambassador. He was obliged to content himself with the approval of the censor of Florence, where the work was printed and published in 1632.

It fell among the theologians of Rome like a bomb-shell. They inveighed loudly against it as not only heretical but blasphemous. They accused its author of openly defying the authority of the Church. And their denunciations of its heresy had all the greater effect with

the Pope, because his self-love had been sorely wounded. He was Simplicio, and that was enough! The Grand Duke of Tuscany interceded in his favour, and through his ambassador made the strongest representations to the Pope. But Urban VIII., convinced that the book was written as a satire upon himself, remained inflexible.

The Holy Office took steps to suspend the sale, and even discussed the advisability of censuring the unfortunate author. Terrified by the outbreak of such a storm, Galileo hastened to place himself under the protection of the Grand Duke of Tuscany; who addressed, by his Secretary of State, Bali Cioli, a letter of explanation and expostulation, suggested by Galileo, and evidently embodying his system of defence. We trust the reader will not be wearied by our insertion of a few extracts from it, which will be necessary to his full understanding of the latter portion of his career:—

"His Highness is exceedingly astonished that a book placed by the author himself in the hands of competent authorities at Rome,—a book read and re-read with care by the examiners,

not with the simple consent, but at the urgent request of the author,—a book afterwards corrected, altered, modified, added to, and erased, in conformity with the will of the supreme ecclesiastical authorities at Rome and Florence, —His Highness is astonished that this book should now appear to be suspected, at the end of two years, and the author and the printer prohibited from publishing any more copies. But His Highness's astonishment is redoubled when he reflects that in the said book neither of the principal systems brought before the reader is represented as gaining the victory over the other. All that is done is to explain the arguments upon which they are supported ; and His Highness is perfectly certain that the author has in view only the welfare of the Holy Church. .....His Highness, persuaded that the war waged against Galileo has no motive but a violent and jealous hatred, directed rather against the author himself than against his book, demands that measure of fair dealing for Galileo which, in all trials and before every tribunal, is conceded to the accused."

This letter was written on the 24th of

August 1632. On the 27th, the Tuscan Ambassador replied that he had addressed to the Pope an official letter, very strongly expressed, in favour of Galileo. And on the 6th of September he wrote:—"In the middle of our conference arrived the Pope. He was in a great rage, and interrupted us suddenly, saying, 'Well, see you that your Galileo has dared to intrude where he should not have planted his feet, and in matters the most perilous and serious which any one could stir up at this time.'"

The Ambassador proceeds with a very interesting narrative of his conversation with the Pope in reference to the Grand Duke's intervention on behalf of Galileo. Urban expressed himself with much vivacity:—"The Holy Office," he said "never gives advice to any person beforehand. This is not its custom. Moreover, Galileo knew very well what were the difficulties in the way, for we ourselves had discussed them with him, and he had heard them from our own mouth."

Two days afterwards, the Inquisition at Florence, by express command of the supreme

authorities, ordered Galileo to repair to Rome, and to present himself before the Holy Office, on a charge of heresy. In vain the Tuscan Ambassador represented to the Pope that Galileo was now an old man and in feeble health, and that if the journey to Rome were insisted upon he would in all probability fall ill and die on the road. The Pope replied that he might travel as slowly as he pleased,* but that come he must. His troubles were of his own seeking; for he, when Cardinal, had warned him against the course he was pursuing. The Ambassador suggested that they arose in the approval which the book had received from Riccardi; but the Pope interrupted him, repeating his complaints of the heresy of Galileo's teaching, and declaring that Riccardi had deceived him.

As Galileo, not unnaturally, showed little anxiety to quit the secure shelter of Florence, Niccolini, the Ambassador, wrote to him on the 26th of December, and again on the 15th of January, begging him to hasten his departure, "for fear," he said, "the authorities should adopt

* "*Piano, piano,*" said the Pope; "in a litter, and quite at his ease."

against you some extreme resolution;" in other words, should pronounce upon him the sentence of excommunication. Thoroughly alarmed, Galileo took leave of his tranquil abode at Arcetri on the 20th of January 1633, and in one of the Grand Ducal litters pursued his way to Rome. He reached the great city on the 13th of February, not a little wondering at the tempest he had provoked. Niccolini, his firm friend, immediately obtained an interview with Pope Urban, whom he endeavoured to incline in the good old man's favour. He trusted, he said, that His Holiness was willing to believe in Galileo's most devout and reverent observance of things ecclesiastical, especially in the matter then under consideration. The philosopher, he continued, was resolved to submit himself wholly and absolutely to the learned judgment and prudent opinion of the Sacred Congregation; and he himself (the Ambassador) had been much edified and greatly comforted by his pious humility.

The Pope answered, that in allowing Galileo to remain at Niccolini's house instead of consigning him to the dungeons of the Holy Office,

he had conferred a favour such as had never before been granted; and that he had showed this leniency because Galileo was the accepted servant of the Grand Duke, and for no other reason.

Niccolini thanked His Holiness most profoundly for this trivial concession to the old age and infirmities of an illustrious scholar and discoverer, and then dwelt upon his feebleness as a reason why sentence should be passed upon him without delay. In reply, the Pope naïvely remarked that it was not the custom of the Holy Office to make haste; that he knew not whether Galileo's affair could be readily settled; but that at all events the indictment was being drawn up. He went on to inveigh bitterly against the unfortunate "Dialogues." The book should never have been written: he had been grossly deceived about it. Niccolini answered evasively, for he did not know into what snares an imprudent utterance might not plunge him. It was clear that His Holiness not only conceived that Galileo's teaching was heretical, but that Galileo also believed what he taught;—"A fine business, truly!" In conclusion, Niccolini, when

recounting the details of the interview, expressed his conviction that, though Galileo might succeed in proving that he was right, the Inquisition would never suffer it to be known that they felt themselves to have been in the wrong. Rome never recedes, never retreats, never acknowledges an error. In the infallibility of its ignorance, it stands immovable.

CHAPTER IV.

GALILEO'S TRIAL AND RECANTATION.

YET once again the Tuscan Ambassador, mindful of the services Galileo had rendered to science, and remembering that his gray hairs deserved respect, supplicated the Pope to be merciful. Urban replied: "I repeat to you that we cannot do less than summon the culprit, when the time of examination arrives, to the Palace of the Inquisition; because it is the usage, and we know no other mode of procedure. May Heaven forgive him for having meddled with these matters, which concern new doctrines and Holy Writ; for it is always better to follow the *common doctrine.* Galileo has been my friend; we have often conversed familiarly together, and eaten at the same table. I regret, therefore, to trouble

him; but it is a matter of religion and the faith."

Niccolini protested that Galileo would fully satisfy the Holy Office, if it would allow him to be heard.

"He will be examined," said the Pope. And he added that it was necessary the astronomer should surrender himself at the Palace of the Holy Office, to be at the disposal of the tribunal.

A summons to the same purport being addressed to him on the 3rd of April, the Ambassador pleaded that the old man was very frail, and that for two days he had done nothing but moan and weep, on account of his sufferings from gout, his burden of years, and his anxiety of mind. Therefore he begged the Pope to allow Galileo to return every evening to the ambassadorial residence, and not detain him a prisoner at the Holy Office. His request, however, was not complied with; and, on the 12th of April, the inventor of the telescope was lodged in an apartment of the Palace of the Inquisition. He was permitted to have the attendance of a servant, to obtain his food from

the embassy, and to walk daily in the open court.

"Tormented with the gout," says a recent writer, "and deprived of the society of the Ambassador and his gracious and sympathizing wife, Galileo seems to have borne his imprisonment with a degree of impatience at variance with his natural serenity. We must bear in mind the ever-present fear that each forthcoming examination might end in the application of the torture. Apart from this, he had no cause for complaint. Since the establishment of the tribunal in 1215, no prisoner had ever been treated with the leniency accorded to Galileo, the Grand Duke's servant. Princes, prelates, and noblemen, all had been consigned to the secret dungeons from the very commencement of their trial. Had Galileo been a scion of a royal house, he could scarcely have met with more consideration, or have been treated with more distinction."

All this is true, and yet Galileo still remains an object of compassion. He was an old man—in his seventieth year; his life had been wholly devoted to the task of enlarging the bounds of

human knowledge; he had never impugned or assailed a single truth of the Christian religion. Was it not hard that he should be a prisoner of the Inquisition, subjected to continual examination, and exposed to the risk of torture, perhaps of the stake, simply because he had avowed a belief that the earth moved round the sun, and that the latter was the immovable centre of our system? But it was not so much against Galileo's astronomical theories that Rome waged war, as against the spirit of free inquiry which Galileo had so fearlessly developed. Conscious of her internal weakness, Rome dreaded even a slight breach in the rampart of error and intolerance which she had raised. She knew how disastrous might be the consequences of even "a single rift;" and she was right. Later experience has shown that the progress of knowledge and the growth of independent thought have been fatal to her claims.

On the 30th of April, before the Inquisition, the aged philosopher earnestly contended that he had not knowingly acted in opposition to the decree of 1616. He produced a certificate from Cardinal Bellarmine, an illustrious patron

of letters; and he insisted that the prohibition against teaching the doctrine of Copernicus, therein expressed, did not contain, any more than the published decree of the Congregation of the *Index*, the terms "in any manner whatsoever;" terms which, in the course of fourteen or sixteen years, had completely escaped his memory. He solemnly affirmed that in his book he had conformed to the obligations imposed upon him by the decree, so far as he could understand them. He did not pretend to exculpate himself from all error, but from all evil intention.

"Having reflected," said Galileo, "on the questions put to me in reference to the order neither to sustain, nor defend, nor teach, in any manner whatever, the condemned doctrine, I have set myself to re-peruse my book, which I have not seen for three years, in order to ascertain whether, contrary to my purest intentions, I had allowed to escape from my pen anything which might be construed into a proof of disobedience, or of a desire to contravene the orders of Holy Church. I have minutely examined it, as if it were a new

book, and by a different writer. I sincerely confess that in many passages, for a reader who did not know me better, the arguments in favour of the false opinion I wished to refute are so developed and presented as to compel conviction, rather than leave entire liberty of choice. And notably the two proofs drawn from the solar spots and the tides are exhibited in such a way as to impose upon the reader by a show of logical rigour which exceeds the author's design, he being really convinced of their insufficiency, and inclined to reject them.

"To excuse myself for having fallen into an error so far from my intentions, I would point out that the setting forth the arguments of one's adversary, in a work in which one proposes to refute them, and especially when one has adopted the dialogue form, should be as clear and accurate as possible. But I will bring forward another excuse,—the readiness with which everybody naturally welcomes the suggestions of his own mind, and the ambition of showing greater penetration than others in the invention of ingenious and specious argu-

ments, even in favour of the most erroneous proposition."

This, of course, is special pleading. Galileo's conviction of the truth of the Copernican system was well known, and even in this able defence he is careful not to impugn it. But his object was to persuade his judges that his book, at all events, contained no heretical opinions; and it must be admitted that he argued with very considerable tact and skill. He did not convince them; but, through the interposition of Cardinal Barberini, he was allowed, towards the end of May, to return to Niccolini's house. On the 21st of June he was again summoned before the Holy Office; and his protestations of innocence being useless, he was conducted on the following day, clad in penitential dress, to the great hall of the Inquisition in the convent of Santa Maria Sopra Minerva. There, before the cardinals and great officials of the Holy See, he was compelled to kneel and hear his sentence,—a sentence which pronounced him strongly suspected of heresy, and condemned him to imprisonment. He was also ordered to repeat

the Penitential Psalms once a week for three years. And finally, he was required to recite the Abjuration which had been dictated beforehand by the Pope.

That his book would be prohibited, the aged astronomer had long foreseen, but he had hoped to escape personal punishment by his complete and almost abject submission. His enemies, however, would not suffer him to escape. And they inflicted upon him the keenest of all penances. They compelled him to abjure what he knew in his heart to be truth. They made him read aloud the recantation of a belief which he still held firmly. For his sensitive nature it would not have been easy to devise anything which could cause a keener pang.

Both the sentence and the abjuration are valuable, as a record of the intolerance of ignorance and the foolishness of bigotry; and as they mark an epoch in the history of science and humanity, we present them here in an English dress, but with some slight abridgment:—

"We:

"Gaspard, with the title of Holy Cross of

Jerusalem, Borgia; Brother Felix Contino, with the title of St. Athanasius, surnamed 'of Ascoli;' Guido, with the title of St. Mary of the People, Bentivoglio; Brother Didier Scaglia, with the title of St. Charles, surnamed 'of Cremona;' Brother Antonio Barberini, surnamed 'of St. Onofrio;'

"Louis Zacchia, with the title of St. Peter-in-Chains, surnamed 'of St. Sextus;'

"Berlingero, with the title of St. Augustine, Gessio;

"Fatrizio de St. Lorenzo;

"Verospi, surnamed 'the Priest;'

"Francesco di St. Lorenzo of Damas, Barberini, and Martin de Santa Maria Novella, Ginetti, deacons;

"By the mercy of God, Cardinals of the Holy Roman Church, and Inquisitors-General against the crime of heresy throughout the Christian commonwealth, specially delegated by the Holy See;

"Seeing that you, Galileo, son of the late Vincenzo Galilei of Florence, aged seventy years, was denounced in 1615 to the Holy Office as holding for true an erroneous doctrine ad-

mitted by numerous people,—namely, that the sun is the centre of the world, and immovable, and that the earth moves with a diurnal motion ;

"Seeing that you had numerous disciples to whom you taught this doctrine ; also, that you maintained a correspondence respecting it with certain German mathematicians ; also, that you published letters on the Spots of the Sun, in which you set forth this doctrine as true ; and that to the objections put forward from Holy Writ, you replied by interpreting it in your own sense ;

"Seeing that, at a later date, a copy was produced of a letter, attributed to your pen, as addressed by you to one of your disciples, wherein the Copernican hypothesis was adopted, and numerous propositions were adopted contrary to the true meaning and authority of the Holy Scriptures ;

"The Holy Tribunal, desirous of removing the inconveniences and difficulties thence arising and continually multiplying, to the great detriment of the Holy Faith, in obedience to the order of our Lord and the most eminent

Cardinals of this supreme and universal Inquisition, the theologian qualificators qualified the two propositions on the fixity of the sun and movement of the earth, as follows :—

"'That to say the sun is the centre of the universe, and devoid of all motion in space, is a proposition absurd and false in philosophy, and formally heretical, in so far as it is expressly contrary to Holy Writ;

"'That to say the earth is not the centre of the world and immovable, but that it moves with a diurnal movement, is a proposition absurd and false in philosophy, and theologically, at least, erroneous in faith;'

"Seeing, then, that we were desirous of proceeding towards you with benignity;

"It was decreed in the Holy Congregation of the 20th February 1616, assembled before His Holiness, that the most eminent Cardinal Bellarmine should order you to abandon the aforesaid doctrine; and that, in case of your refusal, the Commissary of the Holy Office should order you to abandon the aforesaid doctrine, interdicting you from teaching, defending, or discussing it; and that, in case of

your non-submission to this order, you should be flung into prison.

"For the execution of this decree, on the day following, at the palace, and in the presence of the most illustrious Cardinal Bellarmine, after a benign admonition from the said Cardinal, you were ordered by the Commissary of the Holy Office, in the presence of a notary and of witnesses, to renounce absolutely your erroneous opinion, and to abstain, in the future, from defending or teaching it in any manner whatsoever, either by voice or in writing; and yet, after promising obedience, you have relapsed;

"Seeing, then, for the purpose of utterly destroying a doctrine so pernicious, and of preventing it from being again diffused abroad, to the serious injury of the Catholic Faith, the Holy Congregation of the *Index* has promulgated a decree prohibiting the books which treat of this doctrine, and pronouncing it false and entirely contrary to the Sacred and Divine Writings;

"Seeing, finally, that last year there appeared at Florence this book, of which the title

indicated that you were the author, since it is entitled 'Dialogues of Galileo Galilei on the Two Principal Systems of the Universe, those of Ptolemaeus and Copernicus,' and that the Holy Congregation was informed that the publication of this book had resulted in the daily growth of this false opinion of the motion of the earth and the fixity of the sun;

"The aforesaid book was carefully examined, and in it was detected an evident transgression of the aforesaid order which was signified to you; inasmuch as, in this book, you defended the aforesaid opinion already condemned and declared erroneous in your presence, while you have recourse to all kinds of artifices to induce a belief that you abandon it as not proved, and only probable—which is likewise a very grave error, probability not being in any way to be attributed to an opinion definitely declared in opposition to Holy Writ;

"Therefore, by our order, you have been recalled before the Holy Office; where, being questioned, you have acknowledged upon oath this book as having been written by you, and by you given out for printing.

"You have confessed that you began the book about twelve years ago,—that is to say, since the above order was intimated to you; also, that you demanded permission to print it, without making known to those who granted the permission that you had been commanded not to hold, defend, or teach such a doctrine in any way whatsoever.

"You have likewise confessed that it was so written, in many passages, as to induce the reader to believe that the arguments invoked in favour of the erroneous dogma were of a nature rather to force conviction by their potency than to support a refutation; excusing yourself for falling into an error so remote, in your own words, from your intention, by the plea that you had adopted the form of a dialogue, and accordingly had yielded to the inclination, natural to every person, to please himself with the subtlety of his own reasoning, and to seek to display a greater penetration than others by inventing specious and ingenious reasons even for the defence of false propositions;

"Seeing that, a suitable delay having been

accorded you for the preparation of your defence, you have produced a certificate under the hand of his Eminence the Cardinal Bellarmine, which you assert was delivered to you as a protection against the calumnies of your enemies, who pretended that you had abjured, and been punished by the Holy Office; in which certificate it is said: That you have not abjured, and have not been punished, and that there has only been signified to you the declaration made by our Lord the Pope, and promulgated by the Holy Congregation of the *Index*, declaring that the doctrine of the earth's motion and the fixity of the sun is contrary to Holy Writ, and can neither be defended nor supported:

"You have alleged that this certificate not mentioning the words 'to teach' and 'in any manner whatsoever,' these words of the order which had been signified to you had, in the course of fourteen to sixteen years, escaped your memory, and that this was the cause of your not revealing the order, when you asked leave to print,—an allegation which you make, not to exculpate yourself from your error, but

to attribute it to an empty ambition, rather than an evil design :

"But this certificate, produced for your defence, aggravates your position, since it declares the aforesaid opinion contrary to Holy Writ, and shows that, nevertheless, you have dared to expound it, to defend it, and to represent it as probable :

"You cannot, moreover, be exculpated by a printing license which you extorted by artifice and cunning, and by concealing the order which had been imposed upon you :

"And seeing that, in our opinion, you had not spoken all the truth in reference to your intention, we have judged it necessary to resort to a rigorous personal examination ; in which (without any prejudice arising from things confessed by or proved against you), in that which touches the said intention, you have answered catholically :

"For these reasons, having seen and maturely considered the merits of your cause, as well as your avowals and excuses, and everything which could rightly be seen and considered, we pronounce against you the definitive sentence herein under transcribed :—

"After invoking the thrice holy name of our Lord Jesus Christ, and that of his thrice-glorious mother Mary, the ever-virgin, by this definitive sentence, sitting in tribunal, in accordance with the advice and judgment of the reverend masters of sacred theology, and our assessors, we pronounce by this writing on the cause and the causes, which have been debated before us by Charles Sincère, doctor of civil and ecclesiastical law, procuror-fiscal of the Holy Office, and by you, Galileo Galilei, convicted, conformably to the act of process above transcribed, after full inquiry, examination, and confession, as has been said elsewhere, we say, judge, and declare that you, Galileo, above named, for the reasons exhibited in this act, and confessed by you as above, you have rendered yourself strongly suspected of heresy by the Holy Office, in that you have believed and maintained a doctrine erroneous and contrary to the Holy and Divine Scriptures,—namely: that the sun is the centre of the terrestrial system; that it does not move from east to west; that the earth moves, and is not the centre of the universe; and that this

opinion may be supported and defended as probable, although it has been declared and defined contrary to the Holy Scriptures. You have consequently incurred all the censures and penalties enacted and promulgated against delinquents by the sacred canons, and the other constitutions, general and particular; from which penalties it pleases us to absolve you on condition that, with a sincere heart, and without any concealment or reservation, you, in our presence, abjure, cease, and abhor the aforesaid heresies and errors, and all other heresies and errors contrary to the Catholic, Apostolic, and Roman Church, according to the formula we impose upon you:

"And to the end that your pernicious error and grave transgression may not remain unpunished, and to the end also that in the future you may be more circumspect, and may serve as an example to others, we decree that by public edict shall be prohibited the book entitled 'Dialogues of Galileo Galilei;' and we condemn you to the special prison of our Holy Office for a time to be hereafter determined; and, by way of salutary penance, we require

you to recite, for three years, once in each week, the Seven Penitential Psalms ; reserving to ourselves the right of diminishing, modifying, or suppressing entirely the aforesaid penalties and penance.

"And thus we say, pronounce, and declare by sentence, decree, condemn, and reserve by this edict and formula, according to our power and duty."

Imprisonment for an indefinite period in the dungeons of the Inquisition, the obligation to recite once every week for three years the Seven Penitential Psalms, and a public abjuration of his "errors and heresy,"—such were the penalties inflicted on the philosopher-enthusiast, for venturing to assert that the sun did not move !

Galileo's recantation of an error which was not an error, of a heresy which all men of science now know to be the truth, took place on the 22nd of June 1633, at the Church of the Convent of Sta. Minerva, and in the presence of all the prelates and cardinals of the Congregation of the Holy Office. After the sentence

of the unfortunate philosopher had been redelivered, he was compelled to read aloud the following abjuration :—

"I, Galileo Galilei, son of the late Vincenzo Galilei, of Florence, aged seventy years, personally in a condition of judgment, and kneeling before your most eminent and reverend lordships, the Cardinal Inquisitors-General against the crimes of heresy throughout the entire Christian commonwealth, having beneath my eyes the holy gospels which I touch with my hands, I swear that I have always believed, that I believe now, and that with the aid of God I will always believe, whatsoever the Catholic, Apostolic, and Roman Church maintains, recognizes, and teaches. But seeing that after I had received from this same Holy Office the injunction to abandon entirely the false opinion which admits that the sun is the centre of the universe, and does not move, and to abstain from accepting, defending, or teaching, in any manner whatsoever, even by writing, the aforesaid erroneous doctrine; and seeing that after I had received due notification that this doctrine is contrary to Holy

Scripture, I have written and printed a book in which I have expounded the same doctrine, though it was already condemned, and invoked in its favour certain proof, with great efficacy, without attempting any solution; for these reasons I have been judged strongly suspected of heresy—namely, in admitting and believing that the sun is the centre of the universe, and immovable, and that the earth is not the centre, and moves.

"Consequently, wishing to destroy, in the minds of your eminences and of all Catholics, the strong suspicion rightly conceived against me, I, in all sincerity, and without mental reservation, abjure, curse, and detest the aforesaid errors and heresies (*abjuro, maledico, et detestor supradictos errores et hæreses*); and I swear that, for the future, I will neither say nor affirm, by voice or in writing, anything which can raise against me such a suspicion; and that, if I should chance to know any person who may be accused or suspected of heresy, I will denounce him to this Holy Office, or to the Inquisitor and to the Ordinary of the place where I may be residing.

"I, moreover, engage myself by oath to discharge and faithfully observe all the penances which have been or will be imposed on me by this Holy Office.

"If it should ever happen to me (which God forbid!) to contravene by any words of mine these promises, these protestations, and these oaths, I submit myself to all the penalties and punishments which have been decreed and promulgated against such transgressions by the sacred canons and other constitutions of the Church, both general and particular; and in this may God assist me, as well as the holy evangel which I touch with my hands!"

Galileo read this humiliating recantation in a loud voice, and with a panic-stricken soul. Wanting faith in himself and his cause, deficient in that true enthusiasm which never fails or shrinks, he proved false to his own belief, his own teaching. Nor can we accept the excuse put forward by a recent French biographer, that he was an old man, gray with seventy years, and delivered, friendless, to enemies who had sworn and who consummated his ruin. His intellect was as firm and clear as

ever, and he knew the importance of maintaining the claims of free inquiry against the jealous encroachments of the ecclesiastical power.

Some attempts have been made to prove that during his trial he was subjected to the torture of the rack; but the utmost that can be said is, he may have been threatened with it. Be it remembered that he was not friendless. He enjoyed the favour of the Grand Duke of Tuscany, and the active support of the Tuscan Ambassador; and if he had remained constant to the truth, it may reasonably be doubted whether the Court of Rome would have dared to put him to death.

Recent researches have thrown discredit on the old tradition which represented the aged philosopher as rising from his knees, after he had read his recantation, and saying to himself, —*Eppur si muove!* "And still it moves!" (that is, the earth). It is obvious that such an exclamation does not agree with his reply to the last question addressed to him:—"I profess no longer the opinion of Copernicus, since I have been commanded to renounce it. Moreover, I am here in your hands; do with me

what you will!" But if they were not openly spoken by the unfortunate philosopher, the truth they embodied was still treasured in his inmost heart. And though we regret that he yielded to the fear of bodily suffering in the cause of Truth and Science, we know that he underwent a real and bitter martyrdom, in the perpetual regret and remorse which arose from his want of moral heroism.

Galileo's enemies pushed their victory to the utmost, ignorant that it was a victory destined to prove more fatal than a defeat. Copies of the sentence and abjuration were circulated in every direction; and the professors at several universities were commanded to read them publicly. At Florence this grotesque ceremony took place in the famous Church of Santa Croce, whither were summoned all who in that city were known or supposed to have embraced Galileo's opinions. So far the "Pope's Philosophers," the men who shut their eyes to experiment, and wrapped themselves in the dusty garments of antiquity, had unquestionably triumphed; for though they had unwittingly

widened the breach already opened between knowledge and the Papal Church, free inquiry for the time seemed paralyzed by this startling proof of their power. "I have been told," wrote Descartes, the great French philosopher, "that Galileo's system was printed in Italy last year, but that every copy has been burnt at Rome, and himself condemned to some kind of penance. This has astonished me so much that I have almost determined to burn all my papers, or at least never to let them be seen by any one. I do not find that he, who is an Italian, and even a friend of the Pope, as I understand, has been condemned for any other reason than that he has attempted to establish the motion of the earth. I know that this theory was formerly censured by some cardinals; but I thought I had heard that no objection was now made to its being publicly taught, even at Rome."

All who had no reason to apprehend personal danger remained steadfast in their advocacy of a system which observation had proved to be incontestably true. As Pascal has finely said in one of his brilliant letters against the

Jesuits,—"It is in vain that you have procured against Galileo a decree from Rome, condemning his theory of the earth's motion. Assuredly, *that* will never prove it to be at rest; and if unerring evidence show that our globe turns round, not all mankind together can prevent it from turning, nor themselves from turning with it." To this day, the schoolboy, fed on the knowledge accumulated by the labour and suffering of such men as Galileo and Pascal, repeats, in reality, the famous words erroneously attributed to the Florentine astronomer,—*Eppur si muove!*—"And still it moves!"

A writer of a life of Galileo observes, that those men of letters who saw in his punishment only a proof of ignorant passion and blinded superstition, found a pleasure in reverting to a similar blunder committed by the "Holy See" in the middle of the eighth century. A Bavarian bishop, named Virgil, eminent both as scholar and statesman, had asserted the existence of Antipodes, and thus awakened in the bigots of his time no less alarm than did the Copernican system in the seven-

teenth century. Pope Zacharias, who was shocked at the idea of another earth, inhabited by another race of men, and enlightened by another sun and moon,—for such was the shape assumed by Virgil's conjecture in his ignorant eyes,—despatched very strict orders to the Papal legate in Bavaria: "With regard to Virgil, the philosopher,—I know not whether to call him priest,—if he own these perverse opinions, strip him of his priesthood, and drive him from the Church and the altars of God." But as Virgil himself had sometimes acted as legate, and as he possessed the full confidence of his sovereign, it was found impossible to displace him. He regarded with indifference the Papal denunciations, and during the five and twenty years which elapsed before his death retained his opinions, his bishopric, his political influence. Strange to say, he was afterwards canonized!

The most zealous advocates of the Papal system have found it difficult to excuse or justify the severe treatment which Galileo underwent. The historian Tiraboschi has been driven to draw a fine distinction between the

bulls issued by the Pope himself, and the decrees of the Inquisition, which he only sanctioned and approved. He remarks, that even the most fervid Romanist never claimed "infallibility" for the Inquisition; and describes it as a special mark of grace accorded to the Roman Church, that, during the entire period of the fierce struggle between Theology and Science, the Head of the Church was never permitted to compromise his infallible character by formally condemning the Copernican system.

It would seem to be a singular subject for rejoicing—that the infallible Head of an infallible Church was spared from committing a gross blunder! It should surely have been impossible for him to err; and what one would like to know is, why Papal infallibility did not at once recognize a scientific fact which was as clear as the sun at noonday. However, Tiraboschi's apology is inadmissible, unless it be at the same time admitted that many conscientious Romanists have been suffered to remain in a remarkable misapprehension of the nature and sanction of the authority to which Galileo yielded. The books of Copernicus and

Galileo are still included among the works prohibited by the *Index*.

As soon as the degrading ceremony of abjuration was at an end; Galileo was removed, pursuant to his sentence, to the prison of the Inquisition. His detention, however, was not of long duration: at the instance of Niccolini, he was allowed, on the fifth day, to return to the ambassadorial residence. There he remained until the authorities fixed upon his future place of abode. At length they named Sienna; where he arrived in the early part of July, and was hospitably received by the Archbishop Piccolomini. It should be added, that throughout his trial he was consoled by the affectionate sympathy of his daughter, the nun, Maria Celesta. "I wish," she writes to him on the 13th of July, "that I could describe the joy of all the mothers and sisters [of the Franciscan Nunnery at Arcetri] on hearing of your happy arrival at Sienna. Indeed, it was most extraordinary. When the news reached us, Mother Abbess and many of the nuns ran to me, embracing me, and weeping from mingled emotions of tenderness and pleasure."

The Archbishop's house was a secure and delightful refuge; but Galileo could not but remember the "cruel edict" which condemned him to perpetual silence. He suffered much from fits of despondency, and would sometimes complain that he was forgotten by his friends. "Not so," rejoined his daughter; "your name is not struck out, as you say, from the book of the living, neither in the greater part of the world, nor in your own country. Indeed, it seems to me that if for a brief moment your name and fame were clouded, they are now restored to greater brightness than ever: at which I am much astonished, for I know that, generally, *nemo propheta acceptus est in patriâ suâ* [No man is esteemed a prophet in his own country]. I am afraid that if I begin quoting Latin I shall fall into some barbarism. But, in truth, you are more loved and esteemed here than ever."

Galileo's friends urged him to be patient. The old man desired to return to Florence—to his books, his studies, his daughter; but they reminded him that it was as yet too soon to expect the Papal permission. Maria Celesta,

meanwhile, prayed earnestly for his speedy return, and carefully and sagaciously took charge of his worldly affairs. In her letters, which have been preserved, she tells him of the fruit and wine she has sold; she renders a minute account of income and expenditure; she narrates every little domestic incident. "We learn," says the author of *The Private Life of Galileo*, "that the vines had been injured by hail, that thieves had been in the garden, that my lady mule was behaving arrogantly, and would carry no one, now her master was away; that a terrible storm had carried off one end of the roof, and broken in pieces one of the vases which held the orange-trees." There were but few plums, and the wind had stripped off the pears. The lemons had sold well, and with the money she had had masses said for her father. "There are two pigeons in the dove-cot," she writes, "waiting for you to come and eat them; there are beans in the garden waiting for you to gather them. Your tower is lamenting your long absence. When you were at Rome, I said to myself, If he were but at Sienna! Now you are at Sienna, I say, Would

he were at Arcetri! But the will of God be done!" Hearing that the Tuscan Ambassador's opinion was against Galileo's petitioning for further leniency, lest his judges should be irritated and should reply once for all in a decided negative, she represses her yearnings, and writes in a more cheerful tone, bidding her father not to weary of Sienna, where his prison is an earthly paradise.

In December 1633 Galileo was allowed to leave Sienna, and to return to his orchard-girdled home at Arcetri. He found his beloved daughter on the brink of the grave. Anxiety had told on a naturally feeble frame, and was quickened in its work by the pious devotion with which she discharged her conventual duties. Happily, she was permitted to see her father before her gentle spirit passed away. The last glimpse we obtain of her is afforded by Galileo's own words in a letter to his friend Diodati. "I stayed five months," he says, "at Sienna, in the house of the Archbishop; after which my prison was changed to confinement to my own house, a little villa one mile from

Florence, with strict injunctions that I was to entertain no friends, nor to allow the assembling of many friends at a time. Here I lived very peacefully, paying frequent visits to the neighbouring convent, where I had two daughters who were nuns, and whom I loved most dearly; the elder in particular, who was a woman of exquisite mind, singular goodness, and most devotedly attached to me. She had suffered much from ill-health during my absence, and had paid no attention to herself. At length dysentery came on, and she died after an illness of six days' duration, leaving me in deep affliction." Her death took place on the 1st of April 1634. Her real, not her religious name, was Polissena, and she was born in 1601. Galileo had two other children, Virginia and Vincenzio, by his mistress, a Venetian named Marina Gamba. His son turned out a youth of idle and dissolute character, who added greatly by his conduct to Galileo's many trials.

The vine-clad hill of Arcetri, famous for the sweet vine called Verdea, rises, at a short distance from Florence, above the palace of Poggio

Imperiale. On its farther slope stands the Torre del Galle, a tower so-called because surmounted by the figure of a bird for a weather-vane. This was Galileo's observatory, where he made most of those lunar observations to which Milton alludes in his description of Satan's shield, that

> "Hung o'er his shoulders like the moon, whose orb
> Through optic glass the Tuscan artist views
> At evening, from the top of Fiesolé,
> Or in Valdarno, to descry new lands,
> Rivers or mountains, in her spotty globe."

At a short distance from the observatory stands the *Villa del Gioiello,* the philosopher's residence, where he received, it is said, the poet Milton during his tour in Italy. The interview between the aged philosopher and the future author of "Paradise Lost" must have been one of intense interest. It has suggested to Landor an "Imaginary Conversation" of much beauty; but who will not wish that some faithful scribe had written down the eloquent utterances which undoubtedly fell from the lips of those two men of genius? All that we know of it, however, we know from an incidental reference in Milton's *Areopagitica*:—

"I could recount what I have seen and heard in other countries, where this kind of inquisition tyrannizes; when I have sat among their learned men (for that honour I had), and been counted happy to be born in such a place of philosophic freedom as they supposed England was, while themselves did nothing but bemoan the servile condition into which learning among them was brought; that this was it which had damped the glory of Italian wits; that nothing had been written there now these many years but flattery and fustian. There it was that I found and visited the famous Galileo, grown old, a prisoner to the Inquisition, for thinking in astronomy otherwise than the Franciscan and Dominican licensers thought."

It was in 1638 that Milton visited Arcetri. It is not improbable that he was introduced to Galileo by their common friend, the learned Diodati, to whom he has addressed one of the finest of his Latin poems. But the brief record we have already quoted is our only authority on a subject of surpassing literary interest.

CHAPTER V.

LAST YEARS.

BEFORE we proceed to sketch the last years of Galileo's noble life, we desire to place before the reader a passage or two from the great work which secured the censure of the Inquisition, that he may judge of its moderation of tone and elevation of spirit. Declaiming against the pride of ignorance which inspires men to pronounce an arrogant judgment on matters far beyond their comprehension, he thus introduces his interlocutors :—

Simplicio. All this is very good, and it is not to be denied that the heavens may surpass in magnitude the capacity of our imaginations, as also that God might have created the world a thousand times larger than it is ; but we

must not admit that anything is created in vain, that anything is useless in the universe. Now, while we gaze on yonder beautiful arrangement of the planets, disposed around the earth at distances proportioned to the effects they are to produce on us for our benefit, to what purpose should a vast vacancy be interposed between the orbit of Saturn and the starry spheres, containing not a single globe, and altogether void and unprofitable? To what end is this? For whose use and advantage?

Salviati. Methinks we arrogate too much to ourselves, Simplicio, when we assume and affirm that the care of man alone is the adequate and entire work and bound, beyond which the Divine Wisdom and Power does, and disposes of, nothing. I feel confident that Providence omits not a jot of what concerns the government of human affairs; but that there may not be other things in the universe dependent upon His supreme wisdom, I cannot, by the mere aid of reason, bring myself to believe. So that when I am told of the uselessness of an immense space interposed between the orbits of the planets and the fixed stars, empty and valueless,

I reply that it is the highest rashness to attempt by feeble reason to judge the works of God, and to pronounce every part of the universe vain and superfluous which is of no direct utility to ourselves.

Sagredo. Say rather, and I believe you would say better, that we have no means of knowing what is of use to us. And I hold it to be one of the greatest instances imaginable of arrogance and folly, to say that because I know not of what use is Jupiter or Saturn to me, therefore those planets are unnecessary; nay more, that they do not exist in nature. To understand the influence upon us of this or that heavenly body (since you will have it that all have some reference to us), it would be needful to remove it for a while, and then the effect which I am sensible of wanting, I may attribute to that star. Moreover, who will dare to say that the space which they call barren and useless between Saturn and the fixed stars is void of other bodies belonging to the universe? Must it be so because we do not see them? If so, I suppose the four Medicean stars, and the satellites of Saturn, came into the heavens when

we first began to see them, and not before? And, by the same rule, the other innumerable fixed stars had no existence until men discovered them. The nebulæ were only so many white flakes, until with the telescope we converted them into constellations of bright and beautiful stars. Oh the presumptuous, or, rather, Oh the rash ignorance of man!

In another passage he delicately ridicules the affected jargon and empty argument favoured by the admirers of the scholastic philosophy :—

Simplicio. It appears to me that Signor Salviati, with a fine circumlocution, has so clearly explained the cause of these effects, that any common understanding, even though unacquainted with science, may comprehend it: but we, confining ourselves to the terms of art, reduce the cause of these and other similar natural phenomena to *sympathy,* which is a certain agreement and mutual desire arising between things which have the same qualities, —just as,on the other hand, that disagreement and aversion with which other things naturally repel and abhor each other, we style *antipathy!*

Sagredo. And thus, with these two words, they profess to account for the numerous effects and accidents which we see, and not without admiration, to occur in nature. But it seems to me that this mode of philosophizing has a great likeness to the style in which one of my friends was accustomed to paint. On one part of his canvas he would write with chalk,—"Here I will have a fountain, with Diana and her nymphs;" on another,—"There some harriers; in this corner I will have a huntsman, with a stag's head; the rest may be filled up with a landscape of wood and mountain; and what remains to be done may be put in by the colourman:" and so he flattered himself he had painted the story of Actæon, when he had contributed nothing to it beyond the names.

After his settlement at Arcetri in the latter part of 1634, Galileo withdrew himself, so far as the public was concerned, from further observation of the heavens, and confined his great intellect to pursuits less likely to bring him into collision with the jealousy of the Holy Office. His last work of importance was his

"Dialogues on Motion," in 1636. In the same year, he corresponded with the celebrated printers of Amsterdam, the Elzevirs, through his friend Micanzio, on the project of issuing a complete edition of his writings. Among the letters written by Micanzio is an amusing one, in which he intimates that, as Theologian to the Republic of Venice, he has had the gratification of refusing his sanction to a work attacking Galileo and the Copernican system. "A book was brought to me," he writes, "which a monk of Verona has been composing, and wished to print, denying the motion of the earth. I was inclined to let it pass, that the world might have a laugh; for the ignorant beast entitles every one of the twelve arguments which make up his book "an irrefragable and undeniable demonstration," and then adduces nothing but the childish trash which every man of sense has long since discarded. For instance, this poor animal understands so little of geometry and mathematics, that he brings forward as a proof that, if the earth could move, it must necessarily fall, because it has nothing to support it. He ought to have added, that then we should catch all

the quails! But when I found that he spoke indecorously of you, and had had the impudence to record what happened lately, saying that he was in possession of the whole of your process and sentence, I told the man who brought it to me to go and be hanged! However, you know the ingenuity of impertinence, and I doubt not he will succeed elsewhere; he is so in love with his absurdities, that he believes them more firmly than his Bible."

After Galileo's condemnation, the Inquisition had placed him in the list of authors all whose writings, *edita et edenda,* were rigorously prohibited. He experienced much difficulty, therefore, in procuring the printing and publication of his work on *motion;* but after failing at Vienna, at Olmutz, and at Prague, he succeeded in concluding arrangements with the Elzevirs of Amsterdam.

From a letter which he addressed to Peiresc, one of his most trusted friends, in 1636, it is apparent that the aged philosopher felt keenly the injustice with which he had been treated:—

"I have said that I hope for no alleviation

of my sentence,"—he was still forbidden to entertain his friends or teach his pupils,—"and this because I have been guilty of no crime. Had I cared, I might have anticipated grace and pardon; for the transgressions of the subject are the means by which the prince finds occasion for the exercise of mercy and indulgence. Wherefore, when a man is wrongly condemned to punishment, it becomes necessary for his judges to use the greatest severity, in order to cover their own misapplication of the law. This affects me less than people may think possible. For I possess two sources of consolation: first, that not the slightest trace of irreverence towards Holy Church can be found in any of my writings; second, the testimony of my conscience, which none but myself and God in heaven can know thoroughly. And He indeed knoweth that in this cause for which I suffer, though many men might have spoken more learnedly, none, not even the ancient Fathers, could have spoken with more devoutness, or with greater zeal for Holy Church. Could all the frauds, the manœuvres, the deceptions, made use of at Rome, in order to

impose upon the supreme authority,—could all these, I say, be brought to light, the effect would simply be to demonstrate the rectitude and purity of my intentions. And you, who have read my works, are aware that they justify my professions of sincerity. You will have discovered the true cause why, under the mask of religion, I have been persecuted; what it is which now continually assails me and crosses my path, so that no help can come to me from without, even were I able to undertake my own defence. For all the inquisitors have been expressly ordered neither to allow the reprinting of those of my works published many years ago, nor to grant a license to any fresh work which I may desire to publish. Thus I am compelled not only to keep silence towards those who misrepresent my teaching and accuse me of ignorance, but also to endure the mischance, the contempt, and the bitter taunts of men infinitely more ignorant than myself, without proffering a word in self-defence."

The death of his daughter was a great blow to the already feeble health of the much-tried

man of science. It was followed by the deaths of his sister-in-law and her four children, who came to live with him at Arcetri, but soon after their arrival perished of the Plague. Alone, and burdened with bitter memories, Galileo pursued his course of quiet study. In 1637 he made his last astronomical discovery, that of the *libration of the moon.* "I have observed," he writes, "a most remarkable appearance on the moon's surface. Though millions and millions of men have gazed upon her so frequently, I do not find that any have observed the slightest alteration in her surface, but have always supposed that she presented to us the same side. Now I find that such is not the case; that, on the contrary, she changes her aspect, as one who, having his full face turned towards us, should move it sideways first to the right and then to the left, or should raise and then lower it, and lastly incline it first to the right then to the left shoulder. Add to this a second wonder—namely, that these three mutations have their three several periods; the first daily, the second monthly, the third yearly. Now, what connection may not these three lunar

periods have with the daily, monthly, and annual movement of the sea, which, by the consent of all, is governed by the moon?"

With this discovery closed the great astronomer's brilliant career. His sight began to give way, and to his other misfortunes, physical and mental, was added that of blindness. At first he could not repress a murmur; but when assured that the recovery of sight was impossible, he submitted himself to the Divine will with pious resignation. Yet even when he was thus afflicted the malice of his enemies was not relaxed. Twice only was he permitted to quit Arcetri: once in the spring of 1638, when he was allowed to consult a physician in Florence; and again when he went to pay his respects to his patron, the Count de Noailles, at Poggibousi. Once or twice he secretly visited the Grand Duke at Petraia; going from Arcetri in a close carriage at early dawn, and returning under cover of night. After 1638, however, his rapidly increasing infirmities kept him a prisoner at Arcetri.

In the August of that year he received a striking proof of the high estimation in which

he was held by the more enlightened nations of Europe. The States-General of Holland, in acknowledgment of the service his astronomical researches had rendered to navigation, sent a deputation to Arcetri, to present him with a complimentary letter and a chain of gold. They found the aged pioneer of Science blind, and grievously weighed down with infirmity. They read to him the letter, and he returned his grateful thanks for an act of such signal courtesy on the part of the Government of a great nation.

In his last years Galileo was affectionately treated by his friends. Viviani and Torricelli, both of them men of conspicuous ability, acted as his amanuenses as well as companions. From every part of Europe he received tokens of respect and honour. To the last his tried patrons, the Grand Duke and the Archbishop Piccolomini, paid him frequent visits, and supplied him with all he needed. Notwithstanding his burden of physical ailments, gout, rheumatism, blindness, and general debility, his mind preserved its activity unimpaired

He was engaged in the task of enlarging his "Dialogues on Motion," when he was seized with an attack of low fever, accompanied by palpitation of the heart. It proved too much for his weakened frame; and after two months' suffering, bravely and calmly borne, Galileo passed away from the scene of his noble labours, on the evening of the 8th of January 1642, aged seventy-eight.

At first his enemies declared that the heretic's body could not be buried in consecrated ground, but this was overruled by the legal authorities; and the Grand Duke determined that the great astronomer's remains should be interred in the Church of Santa Croce, and that the interment should be attended with the pomp and ceremony due to the fame of a man so illustrious. The Inquisition, however, again interfered, and the Grand Duke found himself compelled to abandon his intention of a public funeral. Galileo was therefore buried privately, in the chapel Del Noviziate, at the end of the corridor leading from the south transept to the principal sacristy of Santa Croce. It was not until 1737 that he was commemorated by a suitable monument.

"In Santa Croce's holy precincts lie
Ashes which make it holier, dust which is
Even in itself an immortality,
Though there were nothing save the past, and this,
The particle of those sublimities
Which have relapsed in chaos;—here repose
Angelo's, Alfieri's bones, and his,
The starry Galileo, with his woes;
Here Machiavelli's earth returned to whence it rose."

BYRON, *Childe Harold*, iv. 54.

According to his friend Viviani, Galileo was of a lively and pleasant countenance; square-built, well-proportioned, and slightly above the average stature. His hair was reddish in hue; his forehead, broad and lofty; his eyes were deep and brilliant. Naturally, he was of a robust constitution; but labour, thought, and anxiety weakened it sadly. He became subject to hypochondriacal attacks, and suffered from many severe illnesses; the result, in part, of the sleepless nights which he devoted to the study of the heavens. In the latter half of his life he was a victim to rheumatism and gout. No physical disabilities, however, could quench the fire of his intellect or weaken its activity. His industry was not less wonderful than the force and perspicacity of his genius. He could not be idle. Constant occupation was necessary to

him; and he was accustomed to say, that persistent work was the best medicine both for mind and body. It was this which enabled him to endure the unremitting persecution inflicted upon him by the bigoted enemies of Science and Truth. We have remarked that at Rome he was not subjected, as was formerly surmised, to the agony of the rack. But we may well ask whether the sufferings, the bitternesses, the vexations of all kinds, to which during the later years of his life he was exposed, were not equal to, or even far harder and harsher than, that physical punishment which he avoided only by his recantation and submission? and whether it is, in truth, an historical error to speak of the "tortures of Galileo"?

In conclusion, we may adopt the words of one of his earlier biographers, which do no more than justice to the character and achievements of a man not less distinguished by the general rectitude of his career than by the brilliancy of his genius and the importance of his discoveries. The numerous inventions due

to his acute and energetic industry; the use of the telescope, and the magnificent discoveries to which it led; the patient investigation of the laws of motion; must be regarded as forming a portion only of his real merits,—as simply particular demonstrations of the enthusiasm with which he everywhere withstood and protested against the despotism of ignorance, appealing boldly from the prejudices and follies of tradition to the judgments of reason and common sense. He claimed, and he bequeathed to us, the right of exercising our faculties in the study of God's revelation of Himself in creation. Idolized by his friends, he deserved their affection by his generous and tender disposition; by his admirable good temper, by the gaiety of his conversation, by his unselfishness, and by the liberality with which he devoted himself and a great part of his limited income to the advancement of their prospects. If an unresting desire to be of service to humanity is everywhere worthy of honour; if its value is immeasurably increased when combined with genius of the highest order; if the gratitude and sympathy of men

are owing to one who, with such titles to regard, is cruelly harassed by an unjust persecution; then, among all the benefactors of mankind, few, if any, more truly deserve our love, our esteem, our homage, than GALILEO GALILEI

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